

**AMENDMENTS TO THE CLAIMS:**

This listing of claims will replace all prior versions, and listings, of claims in the application:

1. (Cancelled)

2. (Currently Amended) The apparatus of claim ~~1~~11, wherein the joint searcher and channel estimator essentially concurrently considers the plural signals provided by the plural antennas for determining plural times of arrival and plural channel coefficients, an arriving wavefront being represented by one of the plural times of arrival and a corresponding one of the plural channel coefficients.

3. (Currently Amended) The apparatus of claim ~~1~~11, wherein the time of arrival and the channel coefficient are essentially concurrently determined by the joint searcher and channel estimator.

4. (Original) The apparatus of claim 3, wherein the time channel coefficient is a composite channel coefficient which takes into consideration channel impulse responses for channels associated with each of the plural antennas in the antenna array.

5. (Currently Amended) The apparatus of claim ~~1~~11, further comprising a detector which utilizes the channel coefficient and the time of arrival to provide a symbol estimate.

6. (Currently Amended) The apparatus of claim ~~1~~11, wherein the wireless communication receiver is a mobile terminal.

7. (Currently Amended) The apparatus of claim ~~1~~11, wherein the wireless communication receiver is a network node.

8. (Currently Amended) The apparatus of claim ~~4~~11, wherein the antenna array comprises a uniform linear array of plural antennas.

9. (Currently Amended) The apparatus of claim ~~4~~11, wherein each of the plural antennas in the antenna array is represented by an antenna index, and wherein the joint searcher and channel estimator comprises:

an antenna signal matrix in which a complex value indicative of the signal received in a sampling window is stored as a function of a sampling window time index and the antenna index;

a matrix analyzer matched in a spatial domain to a direction of arrival, the matrix analyzer generating matrix analyzer output;

an output analyzer which uses the matrix analyzer output to generate the time of arrival and the channel coefficient.

10. (Cancelled)

11. (Currently Amended) A wireless communication receiver comprising:  
an antenna array which comprises plural antennas, the plural antennas providing  
respective plural signals indicative of an arriving wavefront;  
a joint searcher and channel estimator which essentially concurrently considers the  
plural signals provided by the plural antennas for determining both a time of arrival and  
channel coefficient;

~~The apparatus of claim 10,~~  
wherein each of the plural antennas in the antenna array is represented by an  
antenna index, and wherein the joint searcher and channel estimator comprises:  
an antenna signal matrix in which a complex value indicative of the signal  
received in a sampling window is stored as a function of a sampling window time index  
and the antenna index;

a correlator which performs a Fast Fourier Transformation (FFT) calculation to  
generate a correlator output;

an correlator output analyzer which uses the correlator output to generate the time  
of arrival and the channel coefficient;

wherein in performing the calculation the correlator considers a dimensional receptivity vector formed from the antenna signal matrix with respect to a sampling window time index for the plural antennas of the antenna array, the dimensional receptivity vector having a frequency related to a difference between phase components of complex values of the dimensional receptivity vector, there being plural possible frequencies for the dimensional receptivity, the plural possible frequencies being represented by a frequency index; and

wherein for each combination of plural possible frequencies and plural time indexes, the correlator calculates:

$$Y(n,t) = \text{FFT}(n,X(:,t))$$

wherein  $t$  is the sampling window time index;

$X(:,t)$  is the complex antenna matrix, with  $:$  representing all antenna indexes for one sampling window time index;

$n$  is the frequency index.

12. (Original) The apparatus of claim 11, wherein for each combination of plural possible frequencies and plural time indexes, the correlator calculates:

$$Y(n,t) = \sum C_j * \text{FFT}(n,X(:,t)), j = 1, K$$

wherein  $C_j$  is a coding sequence symbol value  $j$  and  $K$  is a length of the coding sequence.

13. (Original) The apparatus of 11, wherein each of the plural possible frequencies for the dimensional receptivity vector represents a different possible direction of arrival of the arriving wavefront.

14. (Original) The apparatus of 11, wherein the correlator output comprises  $Y(n,t)$ , and wherein the correlator output analyzer determines a maximum absolute value  $|Y(n,t)|_{\max}$ , wherein the analyzer uses a sampling window time index  $t_{\max}$  at which  $|Y(n,t)|_{\max}$  occurs as the time of arrival of the arriving wavefront; and wherein the analyzer uses the a frequency index  $n_{\max}$  at which  $|Y(n,t)|_{\max}$  occurs as the direction of arrival of the arriving wavefront.

15. (Original) The apparatus of 14, wherein the correlator output comprises  $Y(n,t)$ , and wherein for each arriving wavefront the correlator output analyzer determines a qualifying absolute value  $|Y(n,t)|_{\max}$ , wherein the analyzer uses a sampling window time index  $t_{\max}$  at which  $|Y(n,t)|_{\max}$  occurs as the time of arrival of the arriving wavefront; and wherein the analyzer uses the a frequency index  $n_{\max}$  at which  $|Y(n,t)|_{\max}$  occurs as the direction of arrival of the arriving wavefront.

16. (Original) The apparatus of 11, wherein the correlator output comprises  $Y(n,t)$ , and wherein the analyzer determines a maximum absolute value  $|Y(n,t)|_{\max}$ , wherein the analyzer obtains an amplitude for the arriving wavefront by dividing  $|Y(n,t)|_{\max}$  by a number of antennas comprising the antenna array.

17. (Cancelled)

18. (Cancelled)

19. (Cancelled)

20. (Cancelled)

21. (Cancelled)

22. (Currently Amended) The method of claim ~~21~~29, further comprising concurrently using the plural signals provided by the plural antennas for determining plural times of arrival and plural channel coefficients for respective plural arriving wavefronts, each of the plural arriving wavefront being represented by one of the plural times of arrival and a corresponding one of the plural channel coefficients.

23. (Currently Amended) The method of claim ~~21~~29, further comprising essentially concurrently determining the time of arrival and the channel coefficient.

24. (Original) The method of claim 23, wherein the time channel coefficient is a composite channel coefficient which takes into consideration channel impulse responses for channels associated with each of the plural antennas in the antenna array.

25. (Currently Amended) The method of claim ~~24~~29, further comprising applying the channel coefficient and the time of arrival to a detector to obtain a symbol estimate.

26. (Currently Amended) The method of claim ~~24~~29, wherein the step of concurrently using the plural signals provided by the plural antennas for determining both a time of arrival and channel coefficient is performed by a joint searcher and channel estimator situated in a mobile terminal.

27. (Currently Amended) The method of claim ~~24~~29, wherein the step of concurrently using the plural signals provided by the plural antennas for determining both a time of arrival and channel coefficient is performed by a joint searcher and channel estimator situated at a network node.

28. (Cancelled)

29. (Currently Amended) A method of operating a wireless communication receiver comprising:

obtaining from plural antennas of an antenna array respective plural signals indicative of an arriving wavefront;

concurrently using the plural signals provided by the plural antennas for determining both a time of arrival and channel coefficient;~~The method of claim 28,~~

associating each of the plural antennas in the antenna array with an antenna index, and wherein the step of concurrently using the plural signals provided by the plural antennas for determining both a time of arrival and channel coefficient is performed by a joint searcher and channel estimator; and further comprising the steps of the joint searcher and channel estimator;

storing a complex value indicative of the signal received in a sampling window in an antenna signal matrix as a function of a sampling window time index and the antenna index;

performing a Fast Fourier Transformation (FFT) calculation to generate a correlator output;

using the correlator output to generate the time of arrival and the channel coefficient;

wherein in performing the FFT calculation the joint searcher and channel estimator considers a dimensional receptivity vector formed from the antenna signal matrix with respect to a sampling window time index for the plural antennas of the antenna array, the dimensional receptivity vector having a frequency related to a difference between phase components of complex values of the dimensional receptivity vector, there being plural possible frequencies for the dimensional receptivity, the plural possible frequencies being represented by a frequency index; and wherein the method further includes:

for each combination of plural possible frequencies and plural time indexes, evaluating the following expression:

$$Y(n,t) = \text{FFT}(n,X(:,t))$$

wherein  $t$  is the sampling window time index;

$X(:,t)$  is the complex antenna matrix, with  $:$  representing all antenna indexes for one sampling window time index;

$n$  is the frequency index.

30. (Original) The method of 29, wherein for each combination of plural possible frequencies and plural time indexes, the method comprises evaluating the following expression:

$$Y(n,t) = \sum C_j * \text{FFT}(n,X(:,t)), j = 1, K$$

wherein  $C_j$  is a coding sequence symbol value  $j$  and  $K$  is a length of the coding sequence.

31. (Currently Amended) The method of ~~28~~29, wherein each of the plural possible frequencies for the dimensional receptivity vector represents a different possible direction of arrival of the arriving wavefront.

32. (Currently Amended) The method of ~~28~~29, wherein the correlator output comprises  $Y(n,t)$ , and further comprising determining a maximum absolute value  $|Y(n,t)|_{\max}$ .

33. (Original) The method of 32, further comprising:  
selecting a sampling window time index  $t_{\max}$  at which  $|Y(n,t)|_{\max}$  occurs as the time of arrival of the arriving wavefront; and  
selecting a frequency index  $n_{\max}$  at which  $|Y(n,t)|_{\max}$  occurs as the direction of arrival of the arriving wavefront.

34. (Original) The method of 32, further comprising determining an amplitude for the arriving wavefront by dividing  $|Y(n,t)|_{\max}$  by a number of antennas comprising the antenna array.

35. (Cancelled)

36. (Cancelled)

37. (Cancelled)

38. (Cancelled)